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ABIES
(*firs*)

F—490515

There are about 40 species of true firs (*Abies*), all native in the Northern Hemisphere. They grow in cool temperate regions and mountains southward to Guatemala, northern Africa, Himalayas, and Taiwan. Seven of the 9 species in the United States are important in forestry.

The trees usually have bark with resin blisters, afterwards usually furrowed. Fir needles are usually flattened or sometimes 4-angled, pointed or notched and are often spreading in 2 rows. They persist for 7 to 10 years.

Male and ovulate strobili develop on the same tree in spring from buds formed along twig growth of the previous year. The upright cylindrical or egg-shaped cones, mostly on topmost branches, mature in one season. They are composed of very many closely overlapping, thin scales. The seeds, usually paired at base of a scale, have broad wings and contain resin cavities. After the cone matures, the scales fall off, while the upright central axis remains on the twig through the winter. Cotyledons usually 5 to 7.

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SUBALPINE FIR (*Abies lasiocarpa* (Hook.) Nutt.)

Other common names: Balsam, white balsam, alpine fir, balsam fir, white fir, and pino real blanco de las sierras; for the variety *arizonica*, álamo de la sierra, corkbark fir.

Subalpine fir, the smallest of the eight species of true firs native to the Western United States, is the most widely distributed North American fir. Along the Pacific coast, the range extends from southeastern Alaska, south of the Copper River Valley (lat. 62° N.), the northwestern limit; east to central Yukon Territory (lat. 64° 30′ N.), the northern limit; south through British Columbia along the Coast Range to the Olympic Mountains of Washington and along both slopes of the Cascades to southern Oregon. It is not found on the western slopes of the Coast Range in southern British Columbia nor along the Coast Range in Washington and Oregon, but it does occur on Vancouver Island (*18*).[1]

In the Rocky Mountain region, it grows from the interior valleys of British Columbia west of the Continental Divide and south of the Peace River (lat. 55° N.), south along the high elevations of the Rocky Mountain system to southern New Mexico and Arizona. In the north, its range extends from the high mountains of central British Columbia, western Alberta, northeastern Washington, Idaho, Montana, northeastern Oregon, to the Wind River Mountains of western Wyoming. In Utah, it grows in the Uinta and Wasatch Mountains, but rarely on the southern plateaus. It is found from southern Wyoming, through the high mountains of Colorado and northern New Mexico, and westward through northeastern Arizona to the San Francisco Mountains. Subalpine fir is a major component of the high-elevation forests of this region.

Corkbark fir (*Abies lasiocarpa* var. *arizonica*) is found mixed with subalpine fir on scattered mountains in southwestern Colorado; northern, western, and southwestern New Mexico; and in the San Francisco Mountains in Arizona.

HABITAT CONDITIONS

Climate

Subalpine fir grows in a cold and humid climate (*19*). Temperature extremes of less than −50° F. to more than 90° have been reported. Even though the tree is widely distributed, it grows within a narrow range of mean temperature conditions. Average annual temperatures are 25° to 40°; average July temperatures are 45° to 60°; and January, 5° to 25°. Frosts may occur any month of the year.

Average precipitation, much of which falls as snow, is more than 20 inches. Half the annual precipitation occurs in late fall or early winter on the Pacific coast and west of the Continental Divide in the northern Rocky Mountains. East of the divide in the northern Rockies and in the central Rockies, the heaviest precipitation comes in late winter and early spring; in the southern Rocky Mountains, during late summer and early fall (*1*, *19*). Annual snowfall varies from about 150 inches in the central Rockies to more than 600 inches in the mountains of the Pacific coast.

Soils and Topography

Subalpine fir tolerates poorer soil and moisture conditions than Engelmann spruce, a common associate throughout much of its range. Soils too wet or too dry for spruce will frequently support subalpine fir.

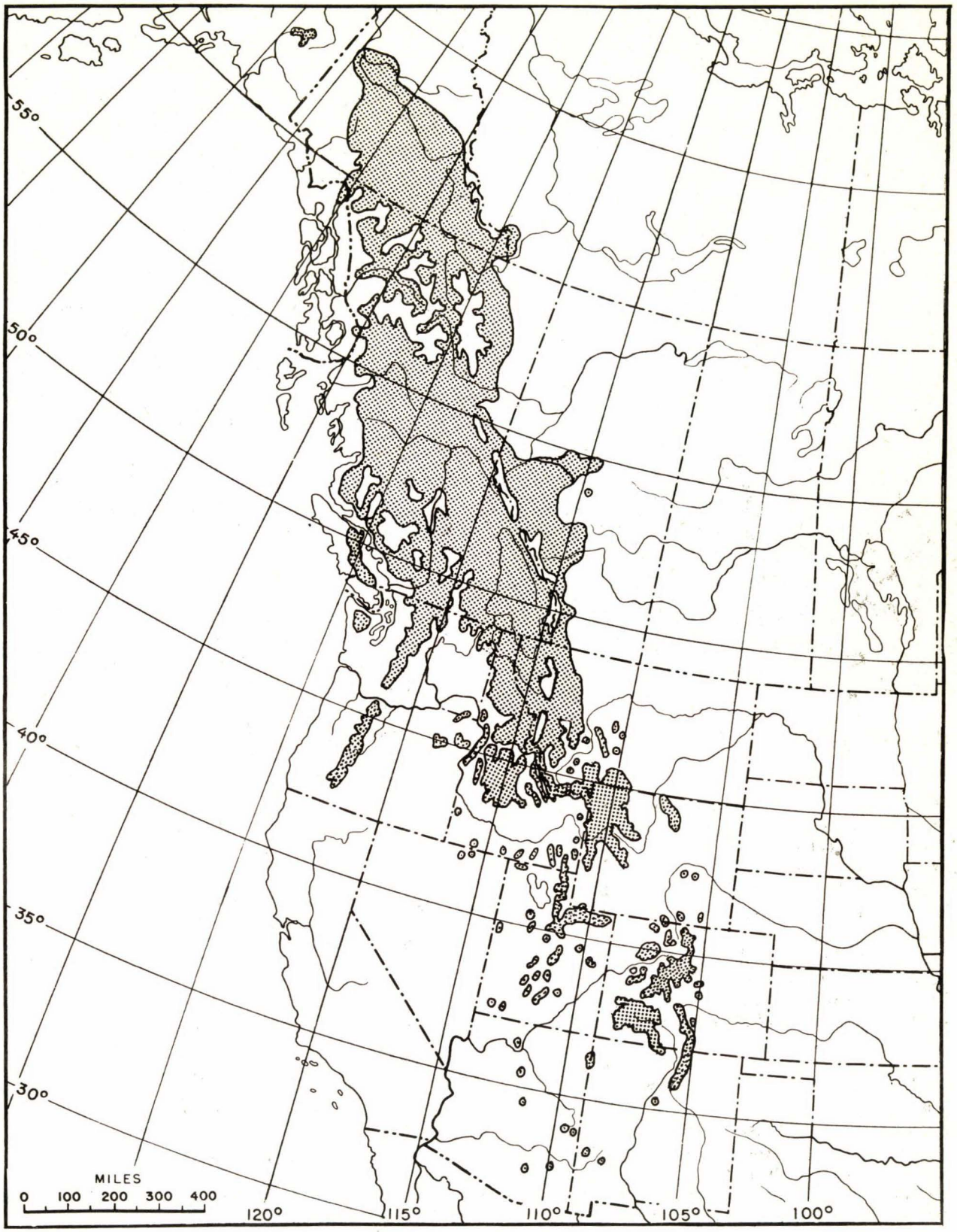
Subalpine fir grows at about sea level at the northern limit of its range and at elevations as high as 12,000 feet in the south. In the Coast Range of southeastern Alaska, it is found from sea level to 3,500 feet; in the Coast Range and interior plateaus of the Yukon Territory and British Columbia, at 2,000 to 5,000 feet; and in the Olympic and Cascade Mountains of Washington and Oregon, usually at 5,000 to 7,500 feet, but sometimes as low as 2,000 feet along cold stream bottoms and as high as 8,000 feet on sheltered slopes (*18*).

In the Rocky Mountains of British Columbia and Alberta south of the Peace River, subalpine fir grows at 3,000 to 7,000 feet but is more abundant above 5,000 feet; in the northern Rocky Mountains, at 2,000 to 11,000 feet, but it is more common at 5,000 to 9,000 feet (*8*, *9*); in the central Rocky Mountains, usually at 9,000 to 11,000 feet, but may be found as low as 8,000 feet and as high as timberline at 11,500 feet; and in the southern Rocky Mountains, at 8,000 to 12,000 feet, but usually on northern slopes at 9,500 to 11,000 feet (*3*, *13*).

Associated Trees and Shrubs

Subalpine fir is a major component of two extensive forest types that occupy the boreal forest region of the mountainous West: Mountain Hemlock—Subalpine Fir (Type 205) and Engelmann Spruce—Subalpine Fir (Type 206). In

[1] Italic numbers in parentheses refer to Literature Cited, p. 40.



The range of subalpine fir.

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Subalpine fir growing at 5,000 feet in the Cascades in Oregon. The tree in the foreground is 65 feet tall.

addition, it is found in eight other adjacent types: White Spruce (Type 201), Whitebark Pine (Type 208), Bristlecone Pine (Type 209), Interior Douglas-Fir (Type 210), Aspen (Type 217), Lodgepole Pine (Type 218), Western Hemlock (Type 224), and Pacific Silver Fir—Western Hemlock (Type 226).

Differences in latitude and elevation influence the composition of the forests in which the subalpine fir grows. In Alaska and the Coast Range of British Columbia through the Cascade Range of Washington and Oregon, mountain hemlock is the most constant associate. In Alaska and northern British Columbia, Alaska-cedar mixes with it, and near sea level in Alaska, it mingles with Sitka spruce. From southern British Columbia southward through the Cascades, it associates at its lower limits with noble fir, grand fir, western hemlock, western white pine, Pacific silver fir, and western larch; and at higher elevations, with Engelmann spruce, lodgepole pine, whitebark pine, and subalpine larch.

From the mountains and interior plateaus of central British Columbia southward through the Rocky Mountain system, its usual associate is Engelmann spruce. Less common associates include white spruce and aspen in British Columbia and western Alberta; western white pine, interior Douglas-fir, western hemlock, western larch, grand fir, and western redcedar at its lower limits in the northern Rocky Mountains; and lodgepole pine, subalpine larch, mountain hemlock, and whitebark pine at higher elevations (*8*, *9*). In the central Rocky Mountains near its lower limits, associates are lodgepole pine, interior Douglas-fir, aspen, and blue spruce; and at higher elevations, whitebark pine, limber pine, and bristlecone pine; and in the southern Rocky Mountains, near its lower limits, white fir, interior Douglas-fir, blue spruce, and aspen; and at higher elevations, corkbark fir (*13*).

Common shrubs found growing with subalpine fir include:

Canadian and northern Rockies (*10*, *11*, *15*)

grouse whortleberry (*Vaccinium scoparium*)
big whortleberry (*V. membranaceum*)
prickly currant (*Ribes lacustre*)
rusty skunkbush (*Menziesia ferruginea*)
alder (*Alnus* spp.)
willow (*Salix* spp.)
elderberry (*Sambucus* spp.)
Greenes mountainash (*Sorbus scopulina*)
river hawthorn (*Crataegus rivularis*)
myrtle boxleaf (*Pachistima myrsinites*)
smooth Labrador tea (*Ledum glandulosum*)
bog kalmia (*Kalmia polifolia*)
red mountainheath (*Phyllodoce empetriformis*)
Mertens cassiope (*Cassiope mertensiana*)

Central Rockies (*5*, *12*)

grouse whortleberry (*Vaccinium scoparium*)
ovalleaf whortleberry (*V. ovalifolium*)
russet buffaloberry (*Shepherdia canadensis*)
mountain snowberry (*Symphoricarpos oreophilus*)
common chokecherry (*Prunus virginiana*)
silver sagebrush (*Artemisia cana*)
bitterbrush (*Purshia tridentata*)
Douglas rabbitbrush (*Chrysothamnus viscidiflorus*)
lanceleaf yellowbrush (*C. lanceolatus*)

Southern Rockies (*14*)

common juniper (*Juniperus communis*)
creeping mahonia (*Mahonia repens*)

Pacific Coast Region

whortleberry (*Vaccinium* spp.)
false azalea (*Azaleastrum albiflorum*)
myrtle boxleaf (*Pachistima myrsinites*)
beargrass (*Xerophyllum tenax*)
smooth Labrador tea (*Ledum glandulosum*)
currant (*Ribes* spp.)

None of these are known to be indicator plants.

LIFE HISTORY

Reproduction and Early Growth

Flowering, seed production, and dissemination.—Male flowers ripen and pollen is disseminated during the late spring and early summer. Cones mature in mid-September or early October; seed ripens from late September to mid-October.

Subalpine fir may begin producing cones when only 20 years old, while the corkbark variety does not begin to bear cones until it is about 50. Maximum seed production is by dominant trees between 150 and 200 years old.

Subalpine fir is rated a good seed producer, better than Engelmann spruce (*10*). Good seed crops are borne on an average of every 3 years, with light crops in between. Total failures occur occasionally.

Seed dissemination begins in September and is usually completed by the end of October. Practically all seed is dispersed by the wind.

Subalpine fir seeds average 37,500 to the pound; corkbark fir seeds are larger, averaging about 22,300 per pound.

Seed-eating animals can be a serious problem when seed supply is limited. One British Columbia study showed that 94.6 percent of the seeds sown on unprotected seed spots were eaten by rodents within a period of 2 weeks (*16*).

Seedling development.—Seed viability is only fair and the vitality is transient (*8*). Subalpine fir's average rate of germination, as shown below, is higher than for most true firs, but lower than those for many associated species.

True firs	*Average germination (percent)*	*Associated species*	*Average germination (percent)*
Subalpine	38	Engelmann spruce	69
Corkbark	31	Lodgepole pine	64
Pacific silver	24	Western larch	27
Grand	28	Western hemlock	56
Noble	24	Mountain hemlock	47
White	34	Sitka spruce	60

Subalpine fir will germinate and survive on a wider range of seedbeds than will Engelmann spruce (*6*). It will survive on duff layers, dry soils, and other places where spruce has failed to become established, presumably because fir has a larger seed and can more quickly produce a vigorous root system (*6*). In one study in Colorado, however, the same number of seeds of subalpine fir, Engelmann spruce, and lodgepole pine were sown on a natural seedbed. Three years later the number of living Engelmann spruce and lodgepole pine seedlings was two and six times greater, respectively, than that of fir (*20*).

Establishment and early survival of subalpine fir are favored by relatively deep shade. It can exist under lower light intensities than most associates, but cannot compete successfully with Engelmann spruce in areas where light intensity exceeds 50 percent of full sunlight (*20*).

Subalpine fir grows very slowly at first. In one study, seedlings 15 years old averaged only 11 inches in height on burned-over slopes, 9.8 inches on cutover, dry slopes, and 5.8 inches on cutover, wet flats (*6*). Trees with less than 5-inch diameters are often 100 or more years old at higher elevations, and trees 4 to 6 feet high and 35 to 50 years old are common under closed-forest conditions (*8, 12*).

Vegetative reproduction.—Subalpine fir at or near timberline frequently reproduces by layering, but under closed-forest conditions reproduction by layering is not important (*6, 12*).

Sapling Stage to Maturity

Growth and yield.—On exposed sites near timberline, subalpine fir is often reduced to a prostrate shrub, but under closed-forest conditions it attains diameters of 18 to 24 inches and heights of 60 to 100 feet. Trees larger than 30 inches in diameter and 130 feet tall are exceptional. Growth is never rapid and trees 10 to 20 inches in diameter are often 150 to 200 years old. Trees older than 250 years are common. But because the species suffers severely from heart rot, many trees either die or are complete culls at an early age (*18*).

This fir usually grows in mixed stands and comprises only a minor part of the volume. In old-growth spruce-fir forests, it usually makes up less than 25 percent of the saw-log volume, which may run from 5,000 to 40,000 board feet per acre for the total stand (*6, 11*).

Competition and principal enemies.—Subalpine fir is classified as very tolerant throughout its life (*2*), more tolerant than any of its associates. With Engelmann spruce throughout most of the Rocky Mountains and mountain hemlock on the Pacific coast, subalpine fir forms a near-stable, high-elevation forest type. As a component of

a near-climax vegetation, the natural tendency is for subalpine fir to reestablish itself after a stand has been destroyed and temporarily replaced by other forest trees.

Subalpine fir will make good diameter growth when released from long periods of suppression. Response to release is more closely associated with number and size of remaining competitors than to degree of suppression or age at time of release (*17*).

In the open, the narrow crowns of both old and young subalpine fir usually extend down to the ground. This fact, combined with the unusually thin bark and resinous character of the tree, makes it extremely susceptible to both ground and crown fires. In very close stands, however, old trees may be found with trunks free of branches for 20 to 40 feet or more (*21*).

Subalpine fir is attacked by several insects. The spruce budworm (*Choristoneura fumiferana*) and black-headed budworm (*Acleris variana*) defoliate it, and the western balsam bark beetle (*Dryocoetes confusus*) at times may be very destructive (*21*).

Balsam fir rust fungus (*Melampsorella cerastii*) and wood-rotting fungi are responsible for most of the disease loss. Important trunk rots are brown stringy rot (*Echinodontium tinctorium*), red heart rot (*Stereum sanguinolentum*), and red ring rot (*Fomes pini*); butt and root rots are shoestring rot (*Armillaria mellea*), brown cubical rot (*Coniophora puteana*), white spongy root rot (*Poria subacida*), and white pocket rot (*Polystictus abietinus*) (*4*, *7*, *22*). Wood rots and broom rusts weaken affected trees and make them more susceptible to wind breakage.

RACES AND HYBRIDS

Abies lasiocarpa var. *arizonica* is the only recognized natural geographical variety of subalpine fir. Horticultural and ornamental varieties have been reported, but these have been oddities.

Revised from "Silvical Characteristics of Subalpine Fir," by R. R. Alexander. U.S. Forest Serv. Rocky Mountain Forest and Range Expt. Sta., Sta. Paper 32, 15 pp. 1958.

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